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Aggregation over different qualities: Are there generic commodities?

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Abstract

Aggregation over goods is always an issue in empirical analysis. However, while the problem of aggregation over different goods often is analysed, little attention has been given to the properties of generic goods such as e.g. coffee, wheat and salmon. Often these generic commodities contain a number of different qualities. In this paper a test for aggregation based on Lewbel's Generalized Composite Commodity Theorem (GCCT) using only price data is used to validate aggregation. We show by using price series for different weight−classes of salmon that the generic term salmon can be used for these products.

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1. Introduction

Aggregation over products is always an issue in empirical economic analysis. This is partly because data are recorded in generic categories like wheat, coffee etc., and partly to give empirical models manageable proportions. It is well known that if goods are aggregated inappropriately, this may introduce serious biases in empirical analysis and cast doubt on the validity of the results (see e.g. Deaton and Muellbauer, 1980 and Lewbel, 1996). However, a recurrent problem is how to validate aggregation over goods for use in empirical estimations. While aggregation issues have been investigated in a number of studies, we are not aware that the appropriateness of generic categories like salmon, tomatoes or tea has been investigated. However, even for most generic categories of this type, there are different quality grades, which may lead goods in the same generic group to form different markets.

There are two fundamentally different approaches to validate aggregation – different forms of separability and relationships between prices (Deaton and Muellbauer, 1980). Relationships between prices have been operationalized for empirical analyses by Lewbel (1996) in his generalized composite commodity theorem (GCCT). Moreover, Asche, Bremnes and Wessells (1999) show that one can obtain information on aggregation from only price data. In this paper we will test for aggregation using only price data, which tend to be the easiest available form of data to investigate this issue. We will here utilize this approach to investigate whether different sizes of salmon can be aggregated into the generic group salmon.

2. The composite commodity theorem

The composite commodity theorem (CCT) of Hicks (1936) and Leontief (1936) provides a condition for the relationships between prices under which it possible to represent the group of goods with a single price and quantity index that is consistent with utility maximization. Following Deaton and Muellbauer (1980), the CCT holds for two goods when

$$P_{1t} = q_t P_{10} \text{ and } P_{2t} = q_t P_{20} \tag{1}$$

Since it is the common trend given by q_t that determines all values of both prices, this implies that the CCT holds when prices are proportional. This relationship holds for any number of goods as long as all prices from a base period are determined by the common trend q_t, which is a representation of the groups price index. The relationship that q_t describes between the prices is strictly deterministic. It is evident that finding such relationship between prices in empirical analysis is near impossible. Real life prices do not exhibit deterministic relationships no matter if they are close substitutes since there always will be some kind of noise influencing the fluctuations. Unfortunately, these arbitrary errors are nontrivial when it comes to aggregation (Lewbel, 1996).

However, Lewbel provides a generalization of the CCT that is empirically useful, the GCCT. Define r_i as the ratio of the price of good *i* to the price index of the group P_I.

$$r_i = \log(p_i / P_I) \tag{2}$$

The aggregation criterion in the GCCT is that the price ratio r_i is independent of the group index P_I. Let $r_i = \ln r_i$ and $R_I = \ln P_I$. For nonstationary prices this is equivalent to find that r_i and R_I is not cointegrated. If so, the residuals u_t in the relationship

$$u_t = r_i - R_I \tag{3}$$

must be nonstationary. This will always be true if the prices and the price index are nonstationary and r_i in equation (3) is stationary, since r_i and the group index R_I then are $I(0)$ and $I(1)$ respectively.

A problem often encountered is that only price data is available in testing for aggregation. The GCCT requires the use of a group index, but the construction of these indexes need both price and quantity data, i.e. like the Paasche index or Laspeyres index. However, as noted by Asche, Bremnes and Wessells (1999), since q_t can be regarded as the price index for the group, this will be nonstationary when the prices are nonstationary. If the prices are proportional with the exception of a stationary deviation, the relative price r_i will be stationary. Moreover, any of the prices will be a scaled representation of q_t, because this is the stochastic trend. Since the order of integration then is different from the group index, the relative price and the price index cannot be cointegrated and the GCCT holds. However, although one can confirm that aggregation is valid with this procedure, one cannot reject the GCCT, since the relative price r_i can be nonstationary and the GCCT may still hold. However, then one needs a different price index for the group.

Asche, Bremnes and Wessells (1999) use their results to argue that the Law of One Price is sufficient for the GCCT to hold. However, their results also indicate that one can investigate whether the GCCT holds by investigating whether the ratio of nonstationary prices are stationary by running Dickey-Fuller tests. When testing for cointegration using Dickey-Fuller tests, a constant term should be included either in the cointegrating relation or in the test for stationarity of the residuals (MacKinnon, 1991). Since we are imposing proportionality in the cointegration relationship, when constructing the relative price a constant term must be included in the Dickey-Fuller test. The test for the GCCT using only prices is then performed by testing whether the relative price r_i is stationary given that the prices are $I(1)$.

3. Empirical results

We will here illustrate how these tests can be used to confirm that a generic name can be used for a product with potential quality differences. The good used in the empirical analysis is salmon, for which weight is an important quality characteristic. We have Norwegian producer prices Atlantic salmon for six different weight classes; 1-2 kg, 2-3 kg, 3-4 kg, 4-5 kg, 5-6 kg and finally 6-7 kg.[1] The prices are recorded on a monthly basis from August 1991 to January 2001. The price series of 4-5 kg is shown in Figure 1 and descriptive statistics are reported in Table 1.[2] We see that the higher weight classes of salmon receive higher prices per kilo than the lower weight classes. However, they also experience larger variations in their prices. From Table 2 we can see that there is a high degree of correlation between the price series, indicating that these prices are closely related. The correlation decreases the farther apart the weight

[1] The prices are provided by the Norwegian Seafood Producers Association (NSL).
[2] This is the price used as a proxy group index for the generic group salmon in the empirical tests.

classes are from each other. Still, prices of 1-2 kg salmon and 6-7 kg salmon are correlated with a coefficient of 0.75, which is relatively high.

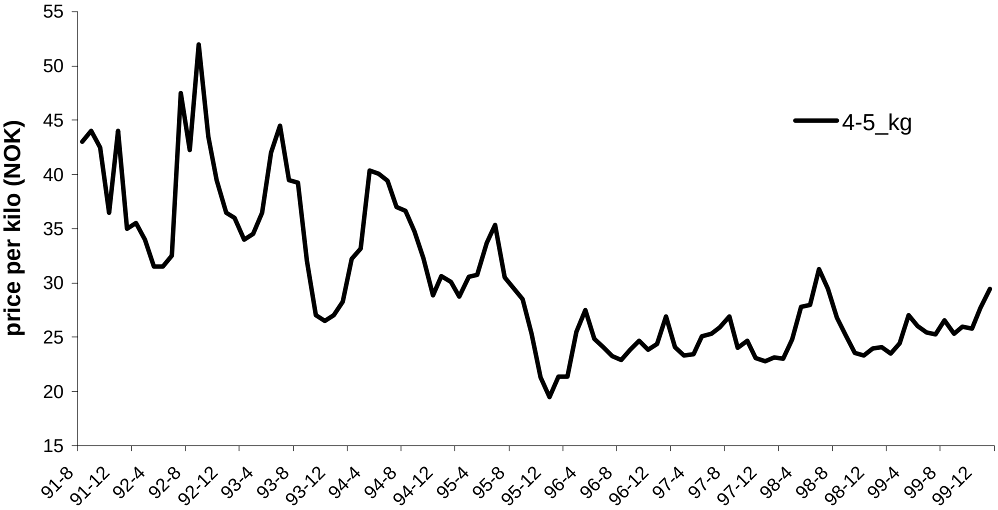

Figure 1 Atlantic salmon price for 4-5 kg weight class from August 1991 to January 2001.

Table 1 Descriptive statistics of salmon price data.

	Means	*Standard deviations*
ln $p_{1\text{-}2\ \mathrm{kg}}$	27.74	5.0421
ln $p_{2\text{-}3\ \mathrm{kg}}$	27.97	5.7556
ln $p_{3\text{-}4\ \mathrm{kg}}$	29.40	6.5804
ln $p_{4\text{-}5\ \mathrm{kg}}$	30.17	6.9259
ln $p_{5\text{-}6\ \mathrm{kg}}$	30.38	7.0912
ln $p_{6\text{-}7\ \mathrm{kg}}$	30.60	7.3086

Table 2 Correlation matrix of salmon prices

	ln $p_{1\text{-}2\ \mathrm{kg}}$	ln $p_{2\text{-}3\ \mathrm{kg}}$	ln $p_{3\text{-}4\ \mathrm{kg}}$	ln $p_{4\text{-}5\ \mathrm{kg}}$	ln $p_{5\text{-}6\ \mathrm{kg}}$	ln $p_{6\text{-}7\ \mathrm{kg}}$
ln $p_{1\text{-}2\ \mathrm{kg}}$	1.0000					
ln $p_{2\text{-}3\ \mathrm{kg}}$	0.9594	1.0000				
ln $p_{3\text{-}4\ \mathrm{kg}}$	0.8629	0.9428	1.0000			
ln $p_{4\text{-}5\ \mathrm{kg}}$	0.7933	0.8983	0.9768	1.0000		
ln $p_{5\text{-}6\ \mathrm{kg}}$	0.7508	0.8576	0.9442	0.9831	1.0000	
ln $p_{6\text{-}7\ \mathrm{kg}}$	0.7500	0.8504	0.9095	0.9487	0.9820	1.0000

We continue by investigating the time-series properties of the variables, using (augmented) Dickey Fuller tests. The results from the tests are reported in Table 3 with the number of lags in parenthesis. The null hypothesis of at least one unit root cannot be rejected for any of the price series. Furthermore, all the first differences of the price variables reject then null of unit root. Thus, we can conclude that all the prices are nonstationary $I(1)$ processes.[3] The next step is to test if the r_i's are

[3] This is as expected since a number of studies have concluded that salmon prices are $I(1)$. See e.g. Gordon, Salvanes and Atkins (1993), Asche (1996), Asche, Bremnes and Wessells (1999) and Asche (2001).

stationary. We normalize by the price of 4-5 kg salmon, as this is the largest group.[4] In Table 4 the Dickey-Fuller tests for r_i's are reported, and in all cases the null hypothesis of nonstationarity is rejected. Hence, we can conclude that the GCCT holds for different weight classes of salmon. This implies that it is valid to use the generic term salmon.

Table 3 Augmented Dickey Fuller tests for unit roots of salmon prices. Monthly observations from Aug 1991 to Jan 2000.

Salmon price variables	*ADF statistics*
$r_{\text{1-2 kg}}$	-2.0289 (4)
$r_{\text{2-4 kg}}$	-2.0181 (4)
$r_{\text{3-4 kg}}$	-2.3396 (4)
$r_{\text{4-5 kg}}$	-2.5255 (4)
$r_{\text{5-6 kg}}$	-2.6707 (4)
$r_{\text{6-7 kg}}$	-2.7472 (4)
$\Delta r_{\text{1-2 kg}}$	-5.2217** (4)
$\Delta r_{\text{2-4 kg}}$	-5.6255** (4)
$\Delta r_{\text{3-4 kg}}$	-6.4949** (4)
$\Delta r_{\text{4-5 kg}}$	-6.8750** (4)
$\Delta r_{\text{5-6 kg}}$	-6.5553** (4)
$\Delta r_{\text{6-7 kg}}$	-6.7269** (4)

Critical values: 5%=-2.892, 1%=-3.499 respectively denoted as * and **. Number of lags used in ADF test in parentheses.

Table 4 Augmented Dickey Fuller tests for unit roots of the log of the ratio, r_i. 4-5 kg price functions as proxy for the group price index R_I. Monthly observations from Aug 1991 to Jan 2000.

$r_i = r_i - R_I$	*ADF test statistics*
$r_{\text{1-2 kg}} - R_I$	-4.7283** (6)
$r_{\text{2-4 kg}} - R_I$	-5.4653** (6)
$r_{\text{3-4 kg}} - R_I$	-5.5012** (6)
$r_{\text{5-6 kg}} - R_I$	-5.7751** (6)
$r_{\text{6-7 kg}} - R_I$	-5.7369** (6)

4. Concluding remarks

Generic commodity names like e.g. salmon, coffee or wheat often include a number of qualities, and one can in many cases question whether it is valid to treat them as one aggregate commodity. The Generalized Composite Commodity Theorem of Lewbel (1996) can be used to confirm that this aggregation is indeed valid using only data on prices. An empirical investigation of prices for different weight classes of salmon indicates that it indeed is valid to aggregate them into the generic category salmon.

[4] Cointegration relationships are in general identified only up to a non-singular transformation. If one want unique relationships one must use a priori information to normalize the relationships (Johansen and Juselius, 1994). They also show that when all data series contain the same stochastic trend, one can arbitrarily normalize upon any data series to create bivariate long-run relationships. The normalization upon the price of 4-5 kg salmon is such an arbitrary normalization which is necessary to be able to test for the GCCT, since this requires bivariate relationships. However, it should be noted that the results are independent of which price we normalize upon.

References:

Asche, F. (1996) “A System Approach to the Demand for Salmon in the European Union” *Applied Economics* 28, 97-101.

Asche, F. (2001) “Testing the effect of an anti-dumping duty: The US salmon market” *Empirical Economics* 26, 343-355

Asche, F., H. Bremnes, and C. R. Wessells (1999) “Product Aggregation, Market Integration and Relationships Between Prices: An Application to World Salmon Markets” *American Journal of Agricultural Economics*, 81, 568-581.

Deaton, A. S. and Muellbauer, J. (1980) *Economics and Consumer Behaviour*, Cambridge University Press. New York.

Gordon, D. V., K. G. Salvanes, and F. Atkins (1993) “A Fish Is a Fish Is a Fish: Testing for Market Linkage on the Paris Fish Market” *Marine Resource Economics* 8, 331-343.

Hicks, J. R. *Value and Capital*. (1936) Oxford: Oxford University Press.

Johansen, S., and K. Juselius (1994) “Identification of the Long-Run and the Short-Run Structure: An Application to the ISLM Model” *Journal of Econometrics*, 63, 7-36.

Leontief, W. (1936) “Composite Commodities and the Problem of Index Numbers” *Econometrica* 4, 39-59.

Lewbel, A. (1996) “Aggregation without Separability: A Generalized Composite Commodity Theorem” *American Economic Review*, 86, 524-561.

MacKinnon, J. (1991) “Critical values for co-integration tests” in R.F Engle and C.W.J. Granger (eds.). *Long-Run Economic Relationships*. Oxford University Press. Oxford.